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ESTIMATING THE GENERAL COGNITIVE COMPONENT OF THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB): THREE FACES OF g

HUMAN RESOURCES

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Multiple methods were used to estimate g (general cognitive ability) from a representative multiple-aptitude test--the Armed Services Vocational Aptitude Battery (ASVAB). These methods were unrotated principal components, unrotated principal factors, and hierarchical factor analysis. By using these methods, estimates of g were made in the ASVAB normative sample and intercorrelated. The intercorrelations were high, ranging from .930 to .999. For the ASVAB, and other sets of variables which display positive manifold, it is argued that the methods are equivalent.

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SUMMARY

Multiple methods were used to estimate **g** (general cognitive ability) from a representative multiple-aptitude test, the Armed Services Vocational Aptitude Battery (ASVAB). These methods included unrotated principal components, unrotated principal factors, and hierarchical factor analysis. Several variants of the hierarchical factor analyses were used, ranging from 3 to 8 factors. Fourteen estimates of **g** were made and computed on the normative sample for ASVAB. The correlations of these estimates were high, ranging from .930 to .999. For the ASVAB, and any other set of variables which display positive manifold, it is argued that the methods are equivalent.

PREFACE

This research and development effort, conducted under Work Unit 7719-18-67, contributes to a better understanding of the constructs underlying the aptitude test used to select enlisted personnel for the Air Force. The nature of the joint services Armed Services Vocational Aptitude Battery is important for its use in selecting and classifying those individuals applying for enlistment in the Air Force. A full understanding of the constructs being measured is needed for proper assignment, classification, retraining and retention.

Many people within the Air Force Human Resources Laboratory (AFHRL) contributed to this effort. Foremost among them is William Tirre, who is owed special thanks for making the necessity of the study clear. Linda Sawin, Lonnie D. Valentine, Jr., Thomas Watson, and William E. Alley contributed to this effort and gave their time freely. Their critical reviews were very helpful. Sgt David Tucker is thanked for his expertise in the computer analyses.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Concluded)

ESTIMATING THE GENERAL COGNITIVE COMPONENT OF THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB): THE THREE FACES OF g

I. INTRODUCTION

Much of early psychological testing began with the assessment of **g** or general ability (Spearman, 1904, 1927). The topic has become of interest to researchers again. One issue is how to estimate **g** from a set of cognitive variables. Frequently these variables are the subtests of a test battery, and **g** is estimated from the variance covariance or correlation matrix.

In practice there are three generally accepted methods of estimating **g** from the data (Jensen, 1987):

1. the unrotated first principal component,

2. the unrotated first principal factor, and

3. the first factor from a hierarchical factor analysis.

The three methods all make use of the intercorrelations of a matrix, and each treats the data with a slightly different model of the relationship between **g** and the observed data. The three models will be discussed here in the order of increasing mathematical complexity. This ordering also turns out to be in increasing order of number of decisions to be made in applying the model and in decreasing order of expected uniformity of results from different investigators.

Each method can produce an estimate of **g**, each has advantages and disadvantages, and each is based on a set of assumptions. Jensen (1987) stated that all three produced similar results for the data sets he investigated. These sets included an individual intelligence test and what he called "real tests." There were no studies on the effects of the methods on multiple-aptitude batteries.

In the present report, all three methods will be applied to a representative multiple-aptitude battery and the **g** estimates compared. Humphreys (1989) implied that the three methods may not give the same results when the variables do not have positive manifold, but this is not an issue for the representative test battery.

Principal Components

Hotelling (1933a, 1933b) developed the principal components method as a way of reorienting the reference axes of a set of data. It analyzes the unreduced correlation matrix (1.0 in each of the diagonal entries) and forms a set of linearly independent component variables from which the original variables can be reproduced. If there are **n** variables in the original matrix, then **n** components can be computed to account for all of the variance in the correlation matrix. The principal components methodology requires no decisions and provides a completely determined result. Component scores may be computed directly, and the first of these is the estimate of **g**. The solution is not rotated as that would distribute a portion of the first component variance among the remaining components.

Principal Factors

The principal or common factors method is similar to the principal components method It analyzes a reduced matrix with some measure of communality in the diagonal (Mulaik, 1972) and reproduces only the common variance. At least one decision is required and that is the estimation of communality. This may be done in several ways, among which are: squared multiple correlations, iterated squared multiple correlations, highest correlation of the variable in the matrix, or the reliability of the variable. Occasionally the communality may be estimated above 1.0 for the iterated squared multiple correlations, creating what have become known as the Heywood cases (Harman, 1967, pp. 117-118). In practice, this is not an insurmountable problem and iterated squared multiple correlations are used successfully. Again, to retain **g** in the first principal factor, the solution is not rotated.

Hierarchical Factor Analysis

For a hierarchical factor analysis, the factorial model can be either principal components or principal factors (or any other factor extraction method); but an oblique rotation and refactoring of the intercorrelations of the matrix of factors is performed. This can be continued until the number of higher-order factors is two or one, at which stage a further factoring is impossible. The first or only factor serves as the estimate of **g**. Although the lower factors can be residualized by the method of Schmid and Leiman (1957), it will have no effect on the factor which estimates **g**. Hierarchical factor analysis will not reproduce all the variance in the matrix. Several decisions are required: the method of factoring at each stage, communality estimation, number of factors at each stage, and angle of oblique rotation. These decisions could lead to different estimates of **g** in hierarchical analyses.

As these three different methods may yield different **g** estimates, the goal of the present investigation was to apply each of the methods (with a number of variants of hierarchical factor analysis) to a single data set to examine the relations among the **g** estimates for a representative multiple-aptitude test battery: the Armed Services Vocational Aptitude Battery (ASVAB).

II. METHOD

Subjects

The subjects were examinees in the normative sample for the ASVAB (Maier & Sims, 1986). Data on this sample were collected in the summer and fall of 1980 and are weighted to be nationally representative of the 18- to 23-year-old American youth popuation. Unweighted the sample consists of 9,173 cases. In weighted form, the sample represents 25,409,193 men and women and serves as the normative base for reporting ASVAB scores. It represents American youth in the age range of military enlistment.

The Armed Services Vocational Aptitude Battery (ASVAB)

The ASVAB is the only enlistment qualification test used by the United States armed services and is therefore one of the most frequently administered tests.

The content of the ASVAB (Table 1) is the result of agreement among the services and represents both empirical and rational judgments as to importance for military testing. There

are 10 separately timed subtests; eight are power tests and two are speeded (Ree, Mullins, Mathews, & Massey, 1982). The ASVAB is both reliable (Palmer, Hartke, Ree, Welsh, & Valentine 1988) and valid (Wilbourn, Valentine, & Ree, 1984), and has been the subject of continuing research for more than 20 years (see, for example, Welsh et al., 1990).

Table 1. **Subtests of the ASVAB**

Subtest	Number of items	Time
General Science (GS)	25	11
Arithmetic Reasoning (AR)	30	36
Word Knowledge (WK)	35	11
Paragraph Comprehension (PC)	15	13
Numerical Operations (NO)	50	3
Coding Speed (CS)	84	7
Auto and Shop Information (AS)	25	11
Mathematics Knowledge (MK)	25	24
Mechanical Comprehension (MC)	25	19
Electronics Information (EI)	20	9

Procedure

The intercorrelations of ASVAB subtests were computed using the weighted normative sample, and **g** was estimated by the three methods. The principal components were computed. The principal factors were computed with communalities estimated by iterated squared multiple correlations. Howard and Cartwright (1962) have shown this to be the most accurate estimate of communality in most cases. Hierarchical factor analyses were conducted using principal components and principal factors for the initial factoring. In each case, six different first-order factor solutions extracting from 3 to 8 factors were computed. The Oblimin (Carroll, 1960) oblique factor rotation method was used in the first-order factor analyses. All higher-order factor analyses were principal components. The reason for this approach is that investigators using principal components for the first-order analysis would not be likely to reduce dimensionality by using principal factors in the hierarchical analyses. Investigators using principal factors analysis in the first-order factor analyses have already reduced the matrix to its common elements; therefore, they would not be expected to reduce it further with a hierarchical analysis based on principal factors. A total of 12 hierarchical factor analyses were performed.

Scores on each of the 14 estimates of **g** were computed for each subject in the sample. The standard scores of the ASVAB subtests were weighted by the score coefficients of the principal components and principal factors. For the hierarchical estimates, the first-order factor scores were computed and weighted in standardized form by the higher-order factor-score coefficients. The 14 estimates of **g** were then correlated.

III. RESULTS AND DISCUSSION

Table 2 shows the matrix of correlations of ASVAB subtest scores computed in the weighted normative sample. All of the correlations were positive and moderate to high, ranging from .225 to .827 with 80% above .500. The highest correlation was between Mathematics Knowledge

and Arithmetic Reasoning, two quantitative measures. The lowest correlation was between Coding Speed and Auto and Shop Information, a speeded subtest and a subtest of specialized knowledge. On average, Coding Speed had the lowest correlations with other subtests.

Table 2. **Intercorrelations of ASVAB Subtests in the Normative Sample**

	GS	AR	WK	PC	NO	CS	AS	MK	MC	EI
GS	---	722	801	689	524	452	637	695	695	760
AR	722	---	708	672	627	515	533	827	684	658
WK	801	708	---	803	617	550	529	670	593	684
PC	689	672	803	---	608	561	423	637	521	573
NO	524	627	617	608	---	701	306	617	408	421
CS	452	515	550	561	701	---	225	520	336	342
AS	637	533	529	423	306	225	---	415	741	745
MK	695	827	670	637	617	520	415	---	600	585
MC	695	684	593	521	408	336	741	600	---	743
EI	760	658	684	573	421	342	745	585	743	---

Note. Decimals omitted.

Principal Components

Table 3 shows the unrotated loadings of the subtests on the principal components. The first component is the **g** estimate.

Table 3. **Unrotated Principal Components Loadings**

	Principal component									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
GS	.88	-.14	-.11	-.14	.05	-.24	-.22	.11	.07	-.18
AR	.87	.04	-.20	.27	.00	.07	.12	.05	-.24	-.15
WK	.87	.08	-.11	-.32	-.02	-.05	-.07	.03	-.19	.22
PC	.81	.21	-.16	-.36	.00	.29	.10	-.03	.13	-.08
NO	.72	.49	.22	.12	-.39	-.03	-.08	-.06	.03	-.01
CS	.63	.57	.39	.01	.32	-.04	.04	.02	.00	.00
AS	.69	-.55	.31	.00	-.09	.05	.13	.26	.04	.03
MK	.82	.15	-.32	.32	.05	-.07	.06	.06	.18	.16
MC	.79	-.39	.11	.20	.10	.24	-.25	-.14	.00	.04
EI	.82	-.38	.07	-.06	.00	-.21	.19	-.29	.01	-.01

Principal Factors

Table 4 shows the unrotated loadings of the subtests on the principal factors. The first factor is the estimate of **g**.

Table 4. **Unrotated Principal Factors Loadings Using Iterated Squared Multiple Correlations**

	Principal factor									
	1	2	3	4	5	6	7	8	9	10
GS	.87	-.13	.10	-.13	-.13	.07	-.05	.03	.00	-.01
AR	.87	.06	-.29	-.09	.07	-.08	.00	.03	-.01	.00
WK	.87	.09	.28	-.17	.02	-.02	-.03	-.02	-.02	.01
PC	.79	.20	.20	-.14	.13	.00	.04	.00	.02	.00
NO	.70	.45	-.01	.24	-.03	-.06	-.04	-.02	.00	-.02
CS	.61	.47	.06	.25	-.01	.07	.04	.02	.00	.01
AS	.68	-.51	.05	.21	.02	-.04	-.05	.01	.01	.02
MK	.81	.16	-.32	-.16	-.06	.02	.00	-.02	.01	.01
MC	.78	-.36	-.12	.12	.10	.11	.00	-.02	-.01	-.01
EI	.81	-.35	.06	.03	-.11	-.06	.10	.00	.00	.00

Hierarchical Factor Analysis

Tables 5 through 10 show the obliquely rotated factor pattern matrices of the ASVAB subtests for the 8-factor through 3-factor solutions using principal components factor extraction. The factor intercorrelations are also shown.

Tables 11 through 16 show the obliquely rotated factor pattern matrices of the ASVAB subtests from 8 through 3 factors using the principal factors method. Factor correlations are also shown. Using the rule of extracting as many factors as values in the eigenvector equal to or greater than 1.0, the higher-order factor analyses of the 8-, 7-, and 6-factor solutions for both the principal components and principal factors yielded two second-order factors. The first factors in these solutions were responsible for a majority of the factor variance. The other six analyses yielded a single second-order factor. In each case, the first (or only) factor was the estimate of **g**. These hierarchical factor solutions are also found in Tables 5 through 16.

Relationships Among the Estimates of g

Table 17 shows the intercorrelations of the estimates of **g**. The highest correlation was between the estimates from the unrotated first principal component and unrotated first principal factor (.999). The lowest correlation in the matrix was .930 between the **g** estimates based on hierarchical factors from the 3- and 8-factor principal factors solutions. The usual solution for ASVAB (Ree et al., 1982) is a 4-factor principal factors analysis. The intercorrelations of **g** estimated from the hierarchical solution of this 4-factor analysis and the principal components and principal factors **g** were .996 and .994, respectively. Though all the solutions did not yield exactly the same estimates, the magnitudes of the correlations (nearly 1.0) indicated that they would all rank individuals in almost the same order. Thus, the solutions could be used interchangeably in practice.

The Wilks (1938) theorem makes these results predictable and to a limited degree generalizable to most measures of human cognitive aptitude which display positive manifold.

Table 5 Obliquely Rotated Factor Pattern for 8 Factors from the Principal Components Solution and Hierarchical Solution

	Factors							
	1	2	3	4	5	6	7	8
GS	60	04	12	15	03	04	-15	-.08
AR	08	01	12	80	04	.10	-.04	-.01
WK	37	04	05	00	13	47	.01	-.11
PC	02	03	00	03	00	93	-.03	.00
NO	01	00	00	00	1 00	-01	.00	.00
CS	[illegible]	1 00	00	00	00	00	00	.00
AS	00	00	98	00	00	-01	.00	.00
MK	06	03	06	96	00	-.03	.00	-.01
MC	00	00	00	00	00	.00	-.99	.00
EI	01	00	00	00	00	00	00	-1.01

Factor	Correlations							
I	1 00							
II	29	1 00						
III	37	22	1 00					
IV	47	52	45	1 00				
V	33	70	31	63	1 00			
VI	49	54	40	62	-59	1 00		
VII	40	-34	-73	-64	41	-49	1 00	
VIII	53	35	-74	62	44	-56	74	1.00

Factor	Hierarchical loadings	
I	63	-10
II	64	59
III	71	53
IV	83	12
V	73	50
VI	78	22
VII	80	37
VIII	84	35

Table 6. **Obliquely Rotated Factor Pattern For 7 Factors from the Principal Components Solution and Hierarchical Solution**

	Factors						
	1	**2**	**3**	**4**	**5**	**6**	**7**
GS	.58	.04	.13	.10	-.09	.11	-.23
AR	-.09	.00	.11	.75	-.07	.12	-.08
WK	.36	.04	.09	-.01	.15	.53	-.03
PC	-.03	.03	-.01	.04	00	.96	.00
NO	.00	.02	-.01	.02	-.98	-.01	.02
CS	-.02	1.00	.00	-.01	.00	.00	.00
AS	-.08	-.02	.83	.10	-.08	.03	-.22
MK	.06	.04	-.04	.90	-.04	-.01	-.03
MC	.06	.04	.06	.11	.00	.02	-.83
EI	.17	.07	.80	.19	.04	.02	.10

Factor				**Correlations**			
I	1.00						
II	.26	1.00					
III	40	.23	1.00				
IV	.45	.51	.45	1.00			
V	-.28	-.69	32	-.59	1.00		
VI	.46	.55	.46	.62	-.59	1.00	
VII	-.24	-.24	-.69	-.49	.33	-.42	1.00

Factor	**Hierarchical loadings**	
I	.50	.07
II	.66	-.43
III	.69	.57
IV	.77	-.05
V	-.74	37
VI	77	-.10
VII	-.62	-.39

Table 7. **Obliquely Rotated Factor Pattern For 6 Factors from the Principal Components Solution and Hierarchical Solution**

	Factors					
	1	2	3	4	5	6
GS	.44	.09	.20	.29	.03	.27
AR	.05	.00	.15	.71	-.13	.11
WK	.28	.06	.03	.06	.08	.65
PC	-.08	.01	-.01	-.01	-.01	1.00
NO	-.03	.06	.02	.08	-.88	.03
CS	.00	1.01	-.01	-.03	-.02	.00
AS	.08	-.02	.95	-.13	-.11	.01
MK	.06	.05	-.06	.90	-.08	.00
MC	-.16	.10	.77	.29	.10	.07
EI	.39	.05	.55	.15	-.02	.05

Factor	Correlations					
I	1.00					
II	.14	1.00				
III	.36	.25	1.00			
IV	.24	.49	.49	1.00		
V	-.17	-.65	-.24	-.46	1.00	
VI	.34	.57	.48	.63	-.54	1.00

Factor	Hierarchical loadings	
I	.45	.66
II	.75	-.44
III	.63	.50
IV	.80	.02
V	-.74	.42
VI	.85	.01

Table 8. **Obliquely Rotated Factor Pattern for 5 Factors from the Principal Components Solution and Hierarchical Solution**

	Factors				
	1	**2**	**3**	**4**	**5**
GS	.57	.03	.30	.21	.07
AR	.08	.00	.12	.73	-.14
WK	.83	.03	.08	.02	-.06
PC	.89	.06	-.09	.01	-.05
NO	.03	.07	.04	.10	-.86
CS	.01	.99	-.01	-.03	-.02
AS	.02	-.02	.97	-.11	-.11
MK	.07	.03	-.07	.89	-.07
MC	-.07	.14	.70	.35	.08
EI	.31	.00	.65	.09	.02

Factor	**Correlations**				
I	1.00				
II	.53	1.00			
III	.51	.23	1.00		
IV	.64	.47	.50	1.00	
V	-.50	-.63	-.19	-.44	1.00

Factor	**Hierarchical loadings**
I	.85
II	.76
III	.61
IV	.81
V	-.73

Table 9. **Obliquely Rotated Factor Pattern for 4 Factors from the Principal Components Solution and Hierarchical Solution**

	Factors			
	1	**2**	**3**	**4**
GS	.58	-.06	.31	.19
AR	.08	.09	.13	.74
WK	.84	.06	.08	.02
PC	.91	.08	-.09	.02
NO	.02	.77	.00	.19
CS	.02	.96	.02	-.08
AS	.01	.05	.97	-.11
MK	.08	.06	-.05	.89
MC	-.08	.04	.74	.32
EI	.31	-.04	.66	.07
Factor	**Correlations**			
I	1.00			
II	.58	1.00		
III	.52	.25	1.00	
IV	.64	.52	.50	1.00
Factor	**Hierarchical loadings**			
I	.88			
II	.73			
III	.70			
IV	.85			

Table 10. **Obliquely Rotated Factor Pattern for 3 Factors from the Principal Components Solution and Hierarchical Solution**

	Factors 1	2	3
GS	.64	-.01	.36
AR	.81	.03	.11
WK	.68	.15	.15
PC	.74	.18	-.02
NO	.20	.76	-.01
CS	-.06	.97	.02
AS	-.14	.05	1.01
MK	.96	-.01	-.08
MC	.23	.00	.73
EI	.29	-.01	.70

Factor	Correlations		
I	1.00		
II	.61	1.00	
III	.59	.29	1.00

Factor	Hierarchical loadings
I	.91
II	.77
III	.76

Table 11. **Obliquely Rotated Factor Pattern for 8 Factors from the Principal Factors Solution and Hierarchical Solution**

	Factors							
	1	2	3	4	5	6	7	8
GS	.25	.05	-.23	-.01	-.35	.10	.11	.10
AR	.05	.00	-.84	.02	.02	.05	.01	.06
WK	.91	.00	.04	05	-.07	.02	.02	-.01
PC	.80	.04	-.06	-.06	.06	.00	.00	.01
NO	.03	.78	-.11	.11	.01	.00	-.01	-.01
CS	.00	.83	.05	-.06	.00	.01	.01	.00
AS	-.02	.03	.05	.12	-.04	.57	.22	.15
MK	.00	.08	-.70	-.03	-.09	.03	.09	-.13
MC	.03	.01	-.06	-.02	.00	.86	-.02	-.03
EI	.03	.00	-.03	.00	.00	.01	.93	.00

Factor	Correlations							
I	1.00							
II	.74	1.00						
III	-.76	-.68	1.00					
IV	-.01	-.03	-.03	1.00				
V	-.53	-.21	.39	-.08	1.00			
VI	.61	.39	-.67	.23	-.45	1.00		
VII	.72	.43	-.66	.29	-.61	.90	1.00	
VIII	.16	-.07	.15	.31	.00	.43	.43	1.00

Factor	Hierarchical loadings	
I	.88	-.22
II	.68	-.45
III	-.83	.36
IV	.19	.64
V	-.62	.02
VI	.86	.28
VII	.92	.27
VIII	.26	.80

Table 12. Obliquely Rotated Factor Pattern for 7 Factors from the Principal Factors Solution and Hierarchical Solution

	Factors						
	1	2	3	4	5	6	7
GS	.40	.01	-.13	.00	-.26	.20	.12
AR	.13	.03	-.65	.06	.06	.17	.05
WK	.88	.00	.00	.05	-.08	.00	.01
PC	.85	.03	-.02	-.04	.07	.00	.00
NO	.00	.80	-.11	.10	.00	.00	-.01
CS	.02	.82	.06	-.07	.00	.01	.01
AS	.01	.02	.12	.13	-.02	.69	.18
MK	.02	.11	-.71	-.05	-.08	.00	.12
MC	.02	.02	-.13	-.06	-.01	.82	-.02
EI	.02	.00	-.04	.00	.00	.02	.83

Factor	Correlations						
I	1.00						
II	.74	1.00					
III	-.68	-.64	1.00				
IV	.05	-.02	.06	1.00			
V	-.38	-.11	.23	-.09	1.00		
VI	.60	.36	-.52	.29	-.34	1.00	
VII	.73	.43	-.55	.32	-.51	.90	1.00

Factor	Hierarchical loadings	
I	.89	-.21
II	.70	-.49
III	-.77	.38
IV	.20	.76
V	-.50	-.31
VI	.83	.29
VII	.91	.30

Table 13. **Obliquely Rotated Factor Pattern for 6 Factors from the Principal Factors Solution and Hierarchical Solution**

	Factors					
	1	2	3	4	5	6
GS	.31	.08	-.19	-.03	-.28	.31
AR	.16	.01	-.71	.02	.09	.15
WK	.84	.01	.00	.04	-.10	.05
PC	.86	.04	-.01	-.03	.05	-.03
NO	-.01	.78	-.14	.09	.01	.02
CS	.04	.82	.07	-.06	-.01	.00
AS	-.01	.02	.08	.06	.00	.94
MK	.00	.10	-.81	-.04	-.09	-.02
MC	.00	.02	-.17	-.14	.04	.76
EI	.14	.00	-.10	.02	-.14	.63

Factor	Correlations					
I	1.00					
II	.73	1.00				
III	-.73	-.65	1.00			
IV	-.09	-.09	.23	1.00		
V	-.47	-.13	.26	-.03	1.00	
VI	.62	.35	-.59	-.01	-.37	1.00

Factor	Hierarchical loadings	
I	.93	.04
II	.77	-.21
III	-.87	.20
IV	-.17	.81
V	-.50	-.53
VI	.75	.21

Table 14. **Obliquely Rotated Factor Pattern for 5 Factors from the Principal Factors Solution and Hierarchical Solution**

	Factors				
	1	2	3	4	5
GS	.31	.03	-.21	.29	-.28
AR	.19	.04	-.65	.17	.09
WK	.84	.02	.01	.05	-.10
PC	.87	.03	-.02	-.03	.06
NO	-.02	.82	-.07	.03	.00
CS	.02	.82	.04	-.02	.00
AS	-.01	.03	.10	.95	.00
MK	.01	.11	-.81	-.02	-.08
MC	.00	.00	-.24	.70	.03
EI	.14	.00	-.10	.63	-.14

Factor	Correlations				
I	1.00				
II	.75	1.00			
III	-.72	-.65	1.00		
IV	.61	.37	-.57	1.00	
V	-.48	-.16	.26	-.39	1.00

Factor	Hierarchical loadings
I	.93
II	.78
III	-.85
IV	.75
V	-.53

Table 15. **Obliquely Rotated Factor Pattern for 4 Factors from the Principal Factors Solution and Hierarchical Solution**

	Factors			
	1	2	3	4
GS	.53	-.05	-.21	.29
AR	.05	.11	-.69	.14
WK	.94	.02	.02	.01
PC	.67	.16	-.08	.03
NO	-.01	.80	-.09	.03
CS	.04	.80	.03	.00
AS	.00	.05	.10	.93
MK	.06	.05	-.86	-.05
MC	-.03	.03	-.28	.67
EI	.29	-.04	-.10	.61

Factor	Correlations			
I	1.00			
II	.69	1.00		
III	-.73	-.65	1.00	
IV	.61	.31	-.57	1.00

Factor	Hierarchical loadings
I	.91
II	.79
III	-.89
IV	.73

Table 16. **Obliquely Rotated Factor Pattern for 3 Factors from the Principal Factors Solution and Hierarchical Solution**

	Factors		
	1	2	3
GS	.42	-.57	-.06
Ah	.33	-.51	.37
WK	.78	-.27	-.22
PC	.77	-.15	-.11
NO	.76	.04	.17
CS	.77	.13	.10
AS	-.09	.89	-.06
MK	.41	.37	.36
MC	-.02	.87	.13
EI	.12	.81	-.06

Factor	**Correlations**		
I	1.00		
II	-.585	1.00	
III	.342	-.060	1.000

Factor	**Hierarchical loadings**
I	.90
II	-.79
III	.50

Table 17. **Intercorrelations of the Estimates of g**

	P8	P7	P6	P5	P4	P3	F8	F7	F6	F5	F4	F3	Pg	Fg
P8	---													
P7	995	---												
P6	984	994	---											
P5	974	989	996	- -										
P4	992	998	994	990	---									
P3	994	997	994	990	995	---								
F8	988	974	953	934	968	969	---							
F7	991	980	963	945	977	974	998	---						
F6	988	992	984	973	992	981	974	983	---					
F5	990	992	984	971	990	982	980	987	998	---				
F4	991	996	991	986	998	991	972	980	994	994	---			
F3	962	974	971	977	983	967	930	945	971	964	982	---		
Pg	998	996	985	977	996	992	985	990	993	993	996	973	---	
Fg	996	994	983	973	994	989	986	991	994	995	996	973	999	---

Note. P indicates principal components factor analysis and F indicates principal factors analysis. The number indicates the number of factors in the lower-order factor analysis. For example, F8 is an 8 first-factor principal factors analysis. Pg and Fg are the unrotated first principal component and principal factor, respectively. Decimal points omitted.

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